

High Spectral Resolution Observations of Comet 21P/Giacobini-Zinner from McDonald Observatory

Anita Cochran (1), Tyler Nelson (2) and Adam McKay (3)

(1) McDonald Observatory, University of Texas at Austin, USA (anita@astro.as.utexas.edu) (2) Astronomy Department, University of Texas at Austin, USA (3) Goddard Space Flight Center/American University, USA

Abstract

We obtained high spectral resolution observations of comet 21P/Giacobini-Zinner (hereafter GZ) on 6 nights using the Tull Coudé Spectrograph (Tull et al. 1995) on the McDonald Observatory 2.7m Harlan J. Smith Telescope (see Table 1, Log of Observations). GZ was of great interest for two reasons: 1) GZ passed within less than 0.5 AU of Earth during these observations, making it relatively bright and 2) GZ is the prototypical depleted comet.

Observations of comets by several groups (A'Hearn et al. 1995; Cochran et al. 2012; Cochran et al. 2015) have shown that the vast majority of comets display similar spectra, but that about 25% of comets show a depletion in C_2 in optical spectra. GZ was one of the first "depleted" comets to be observed and shows a strong depletion of C_2 and C_3 relative to CN and H_2O (Cochran and Barker 1987; Schleicher et al. 1987). The prior observations that identified the class of depleted comets were all done at low spectral resolution or with photometry. Thus, they measure the integrated intensity of the complete molecular band and not individual lines.

The close approach to Earth allowed us to observe GZ in more detail than in previous apparitions by using high spectral resolution ($R=\lambda/\Delta\lambda = 60,000$). The comet was generally well placed in the sky, allowing us to obtain several spectra (up to 6.5 hours) on a single night. The number of spectra obtained on each night and the exposure time for each individual spectrum is listed in Table 1. Each spectrum covers the wavelength region from 3700Å to 1 μm , with the spectra continuous from 3700–5800Å and then increasing interorder gaps redward of 5800Å. The spectra include emissions from CN, C_3 , C_2 , NH_2 , CH, and [O I].

High spectral resolution allows more sensitivity to weak features since the same equivalent width is not diluted by more continuum and other lines and thus the line "sticks out" better. For this project, our goal

was to compare the detailed spectrum of C_2 and other molecules in GZ on a line-by-line basis with those of more normal comets observed with the same instrument. This allows us to determine whether the depletions were uniform across several bands of C_2 or particular transitions were preferentially affected.

Table 1: Log of Observations

Date (UT)	R_h (AU)	Δ (AU)	Num. Spectra	Exposure Time (s)
29 Jul 2018	1.18	0.62	4	1200
30 Jul 2018	1.18	0.61	5	1200
01 Aug 2018	1.16	0.61	13	1800
18 Aug 2018	1.06	0.47	8	1800
20 Aug 2018	1.06	0.46	10	1800
15 Sep 2018	1.02	0.40	5	1200*

* one spectrum on 15 Sep was 900 sec.

Acknowledgements

This research was supported by NASA grant NNX17A186G. The data were obtained at the McDonald Observatory, part of The University of Texas at Austin.

References

- [1] A'Hearn, M. F., R. L. Millis, D. G. Schleicher, D. J. Osip, and P. V. Birch 1995. The ensemble properties of comets: Results from narrowband photometry of 85 comets, 1976–1992. *Icarus* **118**, 223.
- [2] Cochran, A. L. and Barker E. S. 1987. Comet Giacobini-Zinner: A Normal Comet? *Astron. J.* **93**, 329.

- [3] Cochran, A. L., E. S. Barker, and C. L. Gray 2012. Thirty years of cometary spectroscopy from McDonald Observatory. *Icarus* **218**, 144.
- [4] Cochran, A. L., Levasseur-Regourd, A.-C., Cordiner, M., Hadamcik, E., Lasue, J., Gicquel, A., Schleicher, D. G., Charnley, S. B., Mumma, M. J., Paganini, L., Bockelée-Morvan, D., Biver, N. and Kuan, Y.-J., 2015. The Composition of Comets *Space Sci. Rev.*, **197**, 9.
- [5] Schleicher, D. G., Millis, R. L. and Birch, P. V. 1987. Photometric observations of comet P/Giacobini-Zinner, *Astr. and Astophys.* **187**, 531.
- [6] Tull, R. G., MacQueen, P. J., Sneden, C., & Lambert, D. L. 1995, The High-Resolution Cross-Dispersed Echelle White Pupil Spectrometer of the McDonald Observatory 2.7-m Telescope *Pub. A.S.P.*, **107**, 251